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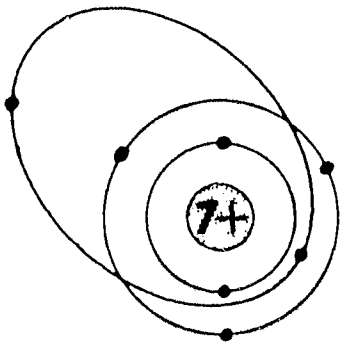
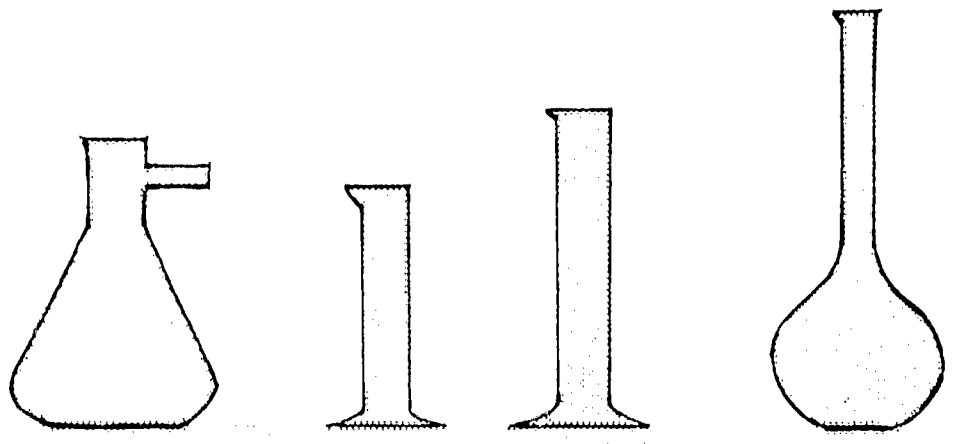
ABSTRACT

This guide discusses the people involved in facility planning and the formulation of program plans. Consideration is given to space requirements, equipment, furniture, and utilities, and to the special needs of different branches of science. A bibliography and planning aids are appended. (RH)





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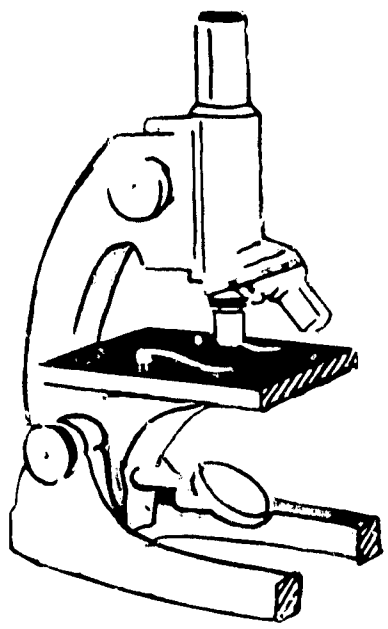
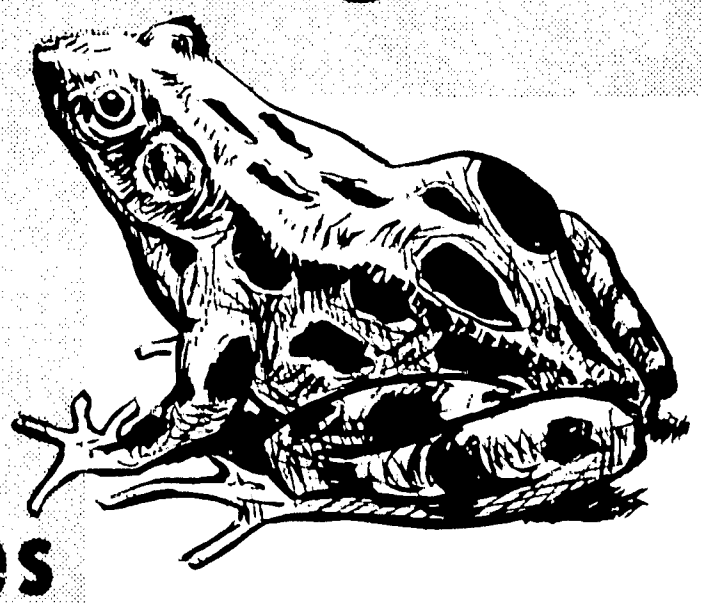
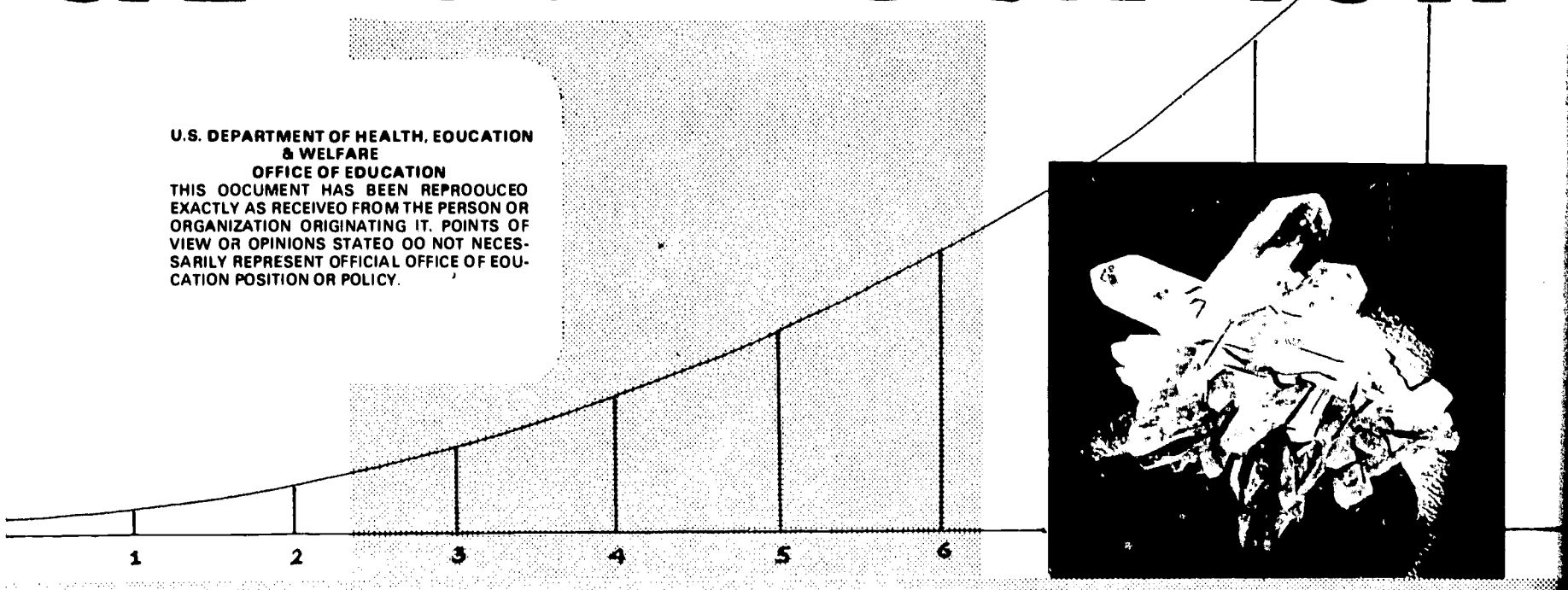




School Facilities FOR

SCIENCE EDUCATION



STATE OF NEW JERSEY DEPARTMENT OF EDUCATION

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FACILITIES FOR SCIENCE EDUCATION

1. Who Should Be Involved In The Planning

As a rule, planning which incorporates the ideas of many people has the best chance of developing the most desirable facilities. *Science teachers* who will be using the facilities certainly should be included in the planning sessions. Planning should also include ideas from *science education leaders*, either by direct consultation or through consideration of the content of their publications. In addition, advice should be solicitated from *informed laymen*. Such persons, together with *school administrators*, *school board members*, and the *school architect*, can contribute much to assuring adequate and functional science facilities.

2. What Are The Necessary Steps In Planning A New Building?

2.1 Initially, school administrators, science teachers, and supervisors should develop *comprehensive educational plans* for the school. These plans should include the following considerations:

- Types and nature of the science courses to be offered
- Projected enrollments for the various courses
- Number of rooms needed
- Space requirements for the rooms
- Desirable location of special rooms within the building
- Furniture and equipment needed for an adequate science program

It is advisable to seek assistance from the County Superintendent of Schools and the Office of Secondary Education of the State Department of Education during the development of the educational plans. Citizens' committees and "outside" educational consultants also can be utilized to good advantage furing this initial planning stage.

2.2 After the educational plans have been formulated, *tentative schematic* plans for the building are developed by an architect. These plans generally are referred informally to the State Department of Education for review and comment.

2.3 After the tentative schematic plans have been reviewed by the school staff, considered informally by the State Department and possible revised as a result, they are presented to the *Local Board of Education for approval.*

3. How Can A School Be Assured It Will Have Adequate Science Facilities?

3.1 A clarification of the role of science education in the school program is essential: usually, a written philosophy is developed. This statement provides persons planning facilities with a rationale, making it possible for them to make decisions with discretion.

A statement, for example, such as the one which follows, may suggest specific facility requirements:

> *"Good science instruction encourages group and individual activities, problem solving in areas that are significant to students, the use of many sources of information as students make discoveries, the verification of ideas by experimentation and by reading from authoritative courses, and the proficient use of fundamental skills."* [1] *Courses which present science as a collection of facts or which are taught by demonstration only, without leading the student to question and experiment, contradict the very nature of science.*

[1] President's Science Advisory Committee, *Education for the Age of Science:* Washington, United States Government Printing Office: 1959.

The suggested facility requirements below seem to follow from this statement:

- Laboratory facilities should be accessible at the time they are needed – A COMBINATION LABORATORY-CLASSROOM IS DESIRABLE.
- All students taking science should have laboratory facilities (even "general" students) – LABORATORY FACILITIES SHOULD BE AVAILABLE TO ALL SCIENCE CLASSES.
- Laboratory experiences should provide opportunities for individual and small group work – FURNITURE AND EQUIPMENT SHOULD BE MOVABLE (WHENEVER FEASIBLE) TO PERMIT FLEXIBILITY IN ARRANGEMENT.
- Problems whose solutions require "crossing the lines of established science disciplines" should be considered by students–MULTI-PURPOSE ROOMS ARE DESIRABLE.
- Many problems to be considered by students should require checking data recorded in written sources – A REFERENCE AREA IS NECESSARY IN THE LABORATORY-CLASSROOM.
- Some individual or small group work will extend beyond a single day's class period – WORK SPACE, WORK AND APPARATUS STORAGE SPACE FOR SUCH WORK SHOULD BE PROVIDED.
- First-hand experiences, whenever feasible, are desirable – SPECIAL FACILITIES ARE NEEDED FOR ACTIVITIES SUCH AS GROWING PLANTS AND KEEPING ANIMALS.

3.2 Space requirements for science facilities should be formulated through a consideration of the total program. It is important to look beyond the immediate needs in the planning of the school and consider the facilities that may be required over a period of years. The inclusion of non-permanent walls, roughed-in plumbing, and provision for future gas and electric service makes conversions of regular classrooms or storerooms to science rooms a relatively simple matter when the need for additional facilities arises.

Experience indicates that an *area* of 50 square feet per student is a minimum when planning science classroom activities. This does not include areas for storage, preparation or student project work; when such areas are included, the per student area should be about 60 square feet.

In terms of usable space, the general over-all *shape* of the science classroom is important. A nearly-square room allows greater flexibility and convenience than a narrow, elongated room.

A decision concerning the *number of classrooms required* for a given course may be reached by using the following formula:

$$\text{No. of rooms} = \frac{\text{(No. of students to take course) X (No. of pds/wk course will meet)}}{\text{(Average class size) X (No. of pds/wk in school schedule) X (0.8)}}$$

3.3 Proper location of science rooms can contribute much to the smooth operation of a science program.

Locating all science rooms in one section of the building encourages free exchange of materials, equipment, activities, and ideas. Rooms to be used primarily for the natural sciences and/or earth sciences should allow easy access to the outdoors for growing plants, field trips to observe natural phenomena, etc. the need for direct sunlight for growing plants in courses such as biology and general science suggests that rooms desired for these courses should have a southern exposure. It should be noted, however, that it is as important to maintain a low brightness-difference ratio in the illumination of science rooms as it is in regular classrooms.

3.4 Care must be taken in *arranging furniture and equipment* so that desirable activities will not be unduly limited. In planning space requirements and furniture arrangement, it is helpful to sketch (to scale) the proposed room on a grid sheet. Then, various arrangements of furniture and equipment can be tried by placing scale cutouts on the grid. A sample grid and page of furniture and equipment cutouts are included in this booklet for your use. (See pages 13 & 14.)

Laboratory furniture companies usually offer excellent planning services which may include scaled equipment floor plan drawings, equipment specifications, and estimated costs. If such service is utilized, thought and development of ideas by the school staff should precede the service, and much sharing of ideas should occur during the process.

Several problems recur consistently when schools are planning furniture and equipment locations and space requirements. Some of these problems together with suggested guidelines for satisfactory solutions follow:

3.41 If *tablet arm chairs* are to be utilized in classroom-laboratories, space should be provided so that students will not be blocked from easy access to laboratory tables and service facilities. Sizes of specific types of arm chairs vary and, thus, the space required for them varies also. It has been found that allowing 6 sq. ft. per arm chair is not always sufficient space to allow the degree of freedom of movement necessary for an active program: careful consideration of the space required for arm chairs is essential.

3.42 The *locations* of doors, partitions, radiators, windows, plumbing fixtures and air ducts can seriously restrict the available space for equipment and furniture. When decisions concerning these locations are made with prior knowledge of anticipated furniture and equipment specifications and location requirements, serious restrictions on the science program brought about by locating utilities and basic structural components can be avoided.

3.43 Installing *movable furniture* rather than non-movable furniture whenever feasible can help make a room useable for many different types of activity. (E.g., small group activity; demonstrations for entire class; individual experimentation.) In this type of arrangement, utilities are usually located in "service islands" or on counters along the periphery of the room, and the work tables are designed so that they can be moved over to utility areas or can be arranged in other positions at will.

3.44 *Reference areas* should be located so that they are easily accessible to students. Also, it is important to have them located away from heat (bunsen burners, hot plates, etc.) and away from water (sinks, troughs, etc.).

3.45 *Storage areas* should be located so that equipment and/or materials in storage are easily accessible to the intended user. (For example, storage space for items to be used for teacher demonstrations should be located near the demonstration desk, and storage space for items to be used by students should be located in the laboratory-classroom in student tables or cabinets.)

3.5 *Utilities* necessary for activities which will be part of the science program should be provided.

Water – Provision for an adequate supply of water with a satisfactory waste disposal system must be made at work stations wherever experiments or other activities require the use and disposal of water. These must also be available in the storeroom and preparation room, the photographic darkroom, and rooms to be used for growth of plants and care of animals.

Possible damage to plumbing through chemical corrosion and amalgamation should be considered when selecting materials for sinks, traps, and waste lines.

Gas – Quality gas cocks, and the inclusion of a master control valve (accessible only to the teacher), are important safety features.

Electricity – Outlets for 110-115 volt a.c. service should be provided at all work stations and at other strategic areas as of the room. Master switches for control of electrical circuits should be readily accessible to the teacher and should be plainly marked.

Attention should be given to providing electrical service at variable voltages, both alternating and direct current. This is usually provided by the use of small portable units which connect to regular 110 volts a.c. outlets. Occasionally schools find it desirable to provide for installation of a central variable voltage distribution panel.

Heating and Ventilating – Special requirements arise from: the need to maintain proper conditions for plants and animals when the school plant is not in operation; the need to maintain adequate ventilation when fume-producing experiments are being carried on, or when the room must be fully darkened. A fume hood should be available and used whenever fume-producing reactions are conducted.

3.6 Appropriate facilities are needed to support an adequate science program. Listings of basic items found in most adequately furnished classrooms throughout New Jersey are given below to serve as checklists of essential itmes to include in new buildings or remodeled classrooms.

3.61 *The General Science Lab-Classroom (Multi-Purpose Science Room).*

- A work surface for each student with available water, gas and electrical utilities.
- A teacher demonstration desk or table.
- Cabinet(s) for storing equipment, including display case(s).
- A preparation and storage area with moveable lab cart or truck, storage cabinets, workspace and shelving for storing chemicals, away from corrosible equipment.
- Fume hood or other special ventilation device to exhaust noxious gases.
- Chalkboard and tackboard area.
- A deep sink for washing glassware and other lab equipment and materials.
- Dark shades or other provision for darkening room for experimentation with or demonstration of light phenomena and for visual aids.
- Moveable planting beds, aquarium, and facilities for keeping small animals.
- An area for reference books, pamphlets and periodicals.
- Seating for classroom discussions and other teaching processes lab-classroom.

3.62 *The Biological Sciences Lab-Classroom*

Its requirements are similar to the General Science room except for the following modifications:

- Work surfaces at a level where students can use microscopes while seated. 110 volt a.c. electric outlets available for substage microscope lamps.
- Areas for keeping animals and plants should have separate temperature and humidity controls.
- Adequately ventilated storage area to keep preserved specimens to be used for dissection.

FURNITURE CUT-OUTS

(Cut-out along dotted lines)

Two-Student Table

Two-Student Table

Two-Student Table

Two-Student Table

Two-Student Table

Two-Student Table

Two-Student Table

Two-Student Table

Two-Student Table

Two-Student Table

Service Counter

Service Counter

Service Counter

Service Counter

Service Counter

Service Counter

Storage Case

Storage Case

Storage Case

Storage Case

Lab Cart

Demonstration Table

Wall Sink

Germinating Bed

Fume Hood

Reference Table

Scale: ¼ in. = 1 ft.

3.7 A Selected Bibliography

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American Association for the Advancement of Science. *The New School Science.* 1515 Massachusetts Avenue, N.W. Washington, D.C. 20005: The Association, 1962, 92 pp.

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Scientific Apparatus Makers Association, *Tentative Minimum Standards: Wood Laboratory Equipment (Furniture).* 20 North Wacker Drive, Chicago 6, Illinois: The Association, 1962, 23 pp.

PERIODICALS

BSCS Newsletter. The Biological Sciences Curriculum Study, P.O. Box 930, Bolder, Colorado 80301. (A Newsletter of particular importance is the "Laboratory Equipment and Supplies Issue," Newsletter Number 21.

Educational Equipment and Materials. Published quarterly. Box 299, Canal Street Station, New York, New York 10013.

The Science Teacher. Published Monthly. The National Science Association, 1201 16th Street, N.W., Washington 6, D.C.

- Should have easy access to the outdoors to permit students to collect meteorological and astronomical and geological data.
- It may be desirable to have a special room designed as a planetarium.

3.66 *The Planetarium*

- The size of the room is directly dependent upon the desired size of the dome. A 24 ft. dome (inside diameter) requires a room 26 ft. square and 20 ft. high. A 30 ft. dome requires a 32 ft. square and 23 ft. high room.
- The room should have special electrical wiring for the planetarium instrument and since the room must be completely darkened, it requires adequate air conditioning.
- Special seating is required.

3.67 *The Elementary School Self-Contained Classroom*

- Counter space around the perimeter of the room with several utility centers each having a sink, hot and cold running water, and an electric outlet.
- Storage space for apparatus and materials can be located under the counters.
- Provision for locating planting beds, aquariums and housing for small animals.
- Easy access to the outdoors for observing natural phenomena. Often an outside area is designed for student use.

3.68 *The Outside Area*

- Planting beds.
- Bird houses.
- Trees and shrubs.
- Small pond (for fish and amphibians).
- Telescope mounting base (it should be located so that an observer will have an unobstructed view of the sky).
- Nature trail.
- Weather station (includes a thermometer, barometer, housed in a louvered structure) a rain guage and a wind direction device.

- Often, a refrigerator is required for specimen storage.
- Special storage cases such as a microscope case and a skelton case.
- Special provision for garbage disposal such as a garbage disposal unit or a quick garbage removal service.

3.63 *The Chemistry Lab-Classroom*

It has requirements similar to the General Science room except for the following modifications:

- Work surfaces must be resistant to acids, bases and organic solvents.
- Shelvings and/or cabinet space for chemical storage should be a part of each work station.
- Additional sinks for washing glassware for experimental procedures utilizing a large amount of water, and washing up after laboratory work.
- Both hot and cold tap water should be provided. In addition, distiiied water should be readily available.
- Fume hood(s). Many chemistry labs include two large fume hoods.
- The preparation room must provide a work area for preparing chemical mixtures for subsequent student use. Shelving for large containers of acids and other toxic or otherwise dangerous materials is essential.
- Safety shower, eye-wash fountain, fire blanket, and appropriate fire extinguishers.
- Usually, facilities for keeping plants and animals are not needed.

3.64 *The Physics Lab-Classroom*

Its requirements are similar to the General Science room except for the following modifications:

- Work surfaces should have smooth uninterrupted surfaces which are non-magnetic and resistant to impacts.
- Considerable storage space for equipment to be used by students for experimentation is needed and should be located in the lab-classroom.
- Usually, facilities for keeping plants or animals are not needed.

3.65 *The Earth Science Lab-Classroom*

Its requirements are similar to the General Science room except for the following modifications:

- Special storage areas for rock and mineral specimens, maps, pictures, and projection slides.
- Work surfaces should be able to withstand the handling of rock specimens. They should be smooth and large enough to permit the study of large topographic maps.
- Should be able to be darkened to allow students to study fluorescent minerals, to observe projection slides of astronomical phenomena, and use demonstration devices such as models of the solar system (orrery or planetarium).

- Should have easy access to the outdoors to permit students to collect meteorological and astronomical and geological data.
- It may be desirable to have a special room designed as a planetarium.

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PLANNING GRID
(Fold Out)

After the perimeter of the room is outlined on the grid, the cut-outs from page 8, and/or other cut-outs of furniture and equipment, can be arranged on the grid to determine possible satisfactory locations.

Scale: ¼ in. = 1 ft.